



Management of Thyroid Emergencies: Clinical Assessment, Diagnosis, and Evidence-Based Treatment Protocols-An Updated Review

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Abstract

Background: Thyroid storm is a rare, life-threatening endocrine emergency characterized by severe thyrotoxicosis accompanied by multiorgan dysfunction. Despite advances in diagnosis and treatment, it remains associated with substantial mortality, particularly when recognition and intervention are delayed.

Aim: This review aims to summarize the clinical presentation, diagnostic approaches, precipitating factors, and evidence-based management strategies for thyroid storm, emphasizing early recognition and prevention of complications.

Methods: A narrative review of clinical and scientific literature was conducted to examine epidemiology, pathophysiology, diagnostic criteria, supportive measures, pharmacological interventions, and advanced treatment options for thyroid storm. Attention was given to the Burch–Wartofsky Point Scale (BWPS), Japanese Thyroid Association/Japan Endocrine Society criteria, and contemporary intensive care management.

Results: Thyroid storm is most associated with Graves' disease and may be precipitated by infection, surgery, trauma, cardiovascular events, parturition, diabetic ketoacidosis, or iodine exposure. Diagnosis remains primarily clinical because thyroid hormone concentrations alone cannot reliably distinguish thyroid storm from uncomplicated thyrotoxicosis. The BWPS and Japanese criteria provide complementary diagnostic frameworks, although both have limitations. Management requires urgent multidisciplinary care, including supportive treatment, beta-adrenergic blockades, antithyroid medications, inorganic iodine, and glucocorticoids. Refractory cases may require adjunctive therapies, therapeutic plasma exchange, emergency thyroidectomy, or extracorporeal circulatory support.

Conclusion: Early diagnosis, prompt multimodal treatment, and appropriate intensive care are essential to improve outcomes and reduce mortality in thyroid storm.

Keywords: Thyroid storm; thyrotoxicosis; Graves' disease; endocrine emergency; diagnostic criteria; intensive care; antithyroid therapy.

Introduction

Thyroid emergencies represent a group of endocrine disorders that require rapid assessment, timely diagnosis, and immediate therapeutic intervention to prevent life-threatening complications. Among these conditions, thyroid storm is the most severe manifestation of thyrotoxicosis and constitutes a medical emergency characterized by profound metabolic disturbance and dysfunction of multiple organ systems. It develops when excessive thyroid hormone activity is accompanied by systemic decompensation, often in association with an acute precipitating event. Although thyroid storm is uncommon, its potential for rapid deterioration and death makes it an important clinical concern in emergency medicine, internal medicine, and intensive care practice [1]. Early recognition and prompt initiation of treatment

are essential to reduce complications and improve patient outcomes. The true incidence of thyroid storm remains difficult to establish because of its rarity and the absence of universally accepted diagnostic criteria. Diagnosis depends primarily on clinical presentation rather than on a specific biochemical threshold. Thyroid hormone concentrations alone cannot reliably distinguish thyroid storm from severe, uncomplicated thyrotoxicosis because substantial overlap exists between these conditions [2]. Consequently, clinicians must integrate the patient's symptoms, physical examination findings, medical history, and evidence of organ dysfunction when evaluating suspected cases. Thyroid storm accounts for approximately 10–16% of hospital admissions involving severe thyrotoxicosis in some reported series, highlighting its clinical importance among patients presenting with marked thyroid hormone

excess [1]. The condition requires emergency treatment based on clinical suspicion rather than waiting for laboratory confirmation.

Graves' disease is the most frequently reported underlying cause of thyroid storm. It is an autoimmune disorder characterized by stimulation of the thyroid-stimulating hormone receptor, resulting in excessive production and release of thyroid hormones. Other causes include toxic multinodular goitre, toxic adenoma, and, less frequently, destructive thyroiditis [2,3]. The identification of the underlying thyroid disorder is important because it influences subsequent definitive management and the prevention of recurrence. However, treatment of the acute crisis must take priority over detailed etiological investigations. Patients with longstanding or poorly controlled hyperthyroidism, inadequate adherence to antithyroid medication, and pre-existing cardiovascular disease may be particularly vulnerable to severe decompensation. Older adults may also present with atypical manifestations, including apathy, confusion, weakness, or unexplained cardiovascular deterioration, which can delay diagnosis. A precipitating event can initiate the transition from compensated thyrotoxicosis to thyroid storm. Common triggers include bacterial or viral infections, surgery, physical trauma, myocardial infarction, stroke, childbirth, diabetic ketoacidosis, and exposure to iodine-containing contrast agents [2]. Abrupt discontinuation of antithyroid medication is another clinically important factor. These events increase physiological stress and may amplify the effects of excessive thyroid hormone activity. In emergency departments, clinicians should therefore assess both the manifestations of thyrotoxicosis and potential underlying triggers. Failure to identify and treat the precipitating condition may prolong the crisis and contribute to persistent organ dysfunction, even when appropriate antithyroid treatment has been initiated.

The clinical presentation of thyroid storm reflects the widespread effects of thyroid hormones on metabolism, thermoregulation, cardiovascular function, and the central nervous system. Common manifestations include high fever, marked tachycardia, palpitations, agitation, anxiety, tremor, sweating, nausea, vomiting, diarrhoea, and abdominal pain. Severe cases may involve atrial fibrillation, acute heart failure, pulmonary oedema, hypotension, shock, delirium, seizures, or coma [3-5]. Cardiovascular manifestations are particularly important because thyroid hormones increase heart rate, myocardial contractility, and oxygen demand. In susceptible individuals, these effects may precipitate cardiac decompensation or worsen pre-existing heart disease. Gastrointestinal and hepatic dysfunction may also occur, with jaundice suggesting significant systemic involvement. The coexistence of fever, tachycardia, neurological disturbance, and gastrointestinal symptoms in a patient with known or

suspected hyperthyroidism should raise immediate concern for thyroid storm. The pathophysiological mechanisms responsible for thyroid storm remain incompletely understood. Available evidence indicates that the severity of the clinical syndrome cannot be explained solely by circulating thyroid hormone concentrations. Patients with thyroid storm may have serum thyroxine and triiodothyronine levels comparable to those observed in patients with severe thyrotoxicosis without systemic decompensation [2,6]. Proposed mechanisms include increased tissue sensitivity to catecholamines, altered thyroid hormone metabolism, differences in hormone transport and cellular uptake, and activation of inflammatory pathways. The contribution of triiodothyronine-mediated effects at the tissue level has also been considered [4]. These mechanisms may act together, producing an exaggerated metabolic response that overwhelms normal physiological compensatory mechanisms. The resulting increase in oxygen consumption, heat production, and cardiovascular demand contributes to the development of multiorgan dysfunction.

Mortality associated with thyroid storm remains substantial despite advances in diagnostic assessment, intensive care, and endocrine treatment. Published studies report mortality rates ranging from approximately 8% to more than 30%, depending on the population studied, disease severity, diagnostic criteria, and availability of critical care resources. In a multicenter French intensive care unit cohort involving 92 patients with definite thyroid storm, in-unit mortality was 17%, while six-month mortality reached 22% [7]. Cardiogenic shock within the first 48 hours of intensive care admission was independently associated with in-unit mortality, with an odds ratio of 9.43. Greater non-cardiovascular organ dysfunction, as measured by the Sequential Organ Failure Assessment score, was also associated with an adverse prognosis. These findings emphasize the importance of identifying cardiovascular instability and organ failure during the initial assessment [8]. Additional factors associated with poor outcomes include advanced age, pre-existing cardiovascular disease, respiratory failure requiring mechanical ventilation, acute kidney injury requiring renal replacement therapy, and delayed initiation of treatment. Persistent hypotension and inadequate tissue perfusion can further compromise renal, hepatic, and neurological function. Although many survivors recover following appropriate treatment, severe illness may result in prolonged hospitalization, functional impairment, or persistent neurological complications in selected cases. Disseminated intravascular coagulation has also been reported as a serious complication of thyroid storm and should be considered when patients develop unexplained bleeding, bruising, thrombocytopenia, or abnormal coagulation parameters [9-14]. Recognition of these complications is important because they may require

additional supportive interventions beyond the direct treatment of thyrotoxicosis.

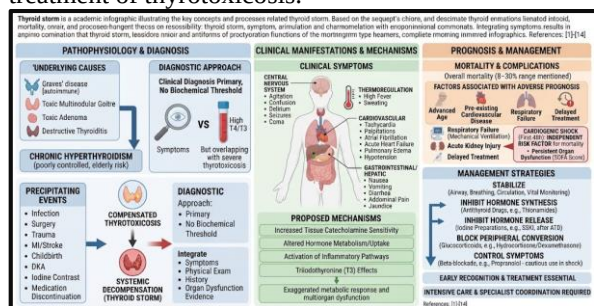


Figure-1: Overview of Thyroid Storm.

The management of thyroid storms requires a coordinated approach involving emergency physicians, endocrinologists, intensivists, cardiologists, and other relevant specialists. Initial care focuses on the assessment and stabilization of airway, breathing, and circulation, followed by continuous monitoring of vital signs, cardiac rhythm, oxygenation, temperature, urine output, and neurological status. Treatment generally combines supportive measures, antithyroid medication, inhibition of thyroid hormone release, reduction of peripheral thyroid hormone effects, and management of the precipitating cause. Beta-adrenergic blockades may control excessive sympathetic manifestations, but its use requires careful assessment in patients with hypotension, low-output heart failure, or cardiogenic shock. Antithyroid drugs are used to inhibit new hormone synthesis, while iodine preparations may be administered after an appropriate interval following the antithyroid medication. Glucocorticoids may reduce peripheral conversion of thyroxine to triiodothyronine and provide additional benefit when adrenal insufficiency is a concern. The precise regimen should be individualized according to clinical severity, contraindications, and the patient's hemodynamic status [12-14]. Access to timely diagnosis and treatment may also be influenced by socioeconomic circumstances, healthcare availability, and medication adherence. Socioeconomic deprivation and lack of health insurance have been associated with higher hospitalization rates for thyrotoxicosis and thyroid storm in some populations [14]. These observations suggest that delayed presentation, limited access to routine endocrine follow-up, and interruptions in medication use may contribute to preventable emergencies. Patient education, continuity of care, medication review, and early treatment of infections or other acute illnesses are therefore important components of prevention. Overall, thyroid storm remains a high-risk endocrine emergency in which clinical deterioration may occur over a short period. Its diagnosis requires recognition of the characteristic clinical syndrome, identification of precipitating factors, and assessment of cardiovascular and other organ dysfunction. Because no isolated laboratory

result reliably distinguishes thyroid storm from severe thyrotoxicosis, treatment should not be delayed while awaiting confirmatory investigations when clinical suspicion is high. A structured emergency assessment, prompt initiation of appropriate therapy, effective management of the underlying trigger, and early escalation to intensive care when indicated are central to improving outcomes. A clear understanding of the clinical features, diagnostic principles, complications, and treatment strategies is therefore essential for healthcare professionals involved in the emergency management of thyroid disorders.

Recognition and Diagnosis

Thyroid storm is a life-threatening endocrine emergency characterized by severe clinical manifestations of thyrotoxicosis accompanied by systemic decompensation and dysfunction of one or more organ systems. Its recognition requires rapid clinical assessment because deterioration may occur within hours, particularly when an underlying precipitating condition remains untreated. Unlike many other medical emergencies, thyroid storm cannot be diagnosed using a single biochemical measurement or a universally accepted diagnostic test. Serum thyroid hormone concentrations may be markedly elevated, but they frequently overlap with those observed in patients with severe thyrotoxicosis who do not develop a thyroid crisis. Consequently, diagnosis depends on the integration of clinical manifestations, thyroid function tests, the patient's medical history, potential precipitating factors, and evidence of organ dysfunction [2,6,9]. The clinical presentation typically involves hyperthermia, marked tachycardia, cardiovascular instability, neurological disturbances, and gastrointestinal or hepatic dysfunction. Fever, often exceeding 38.5°C, may accompany profuse sweating, dehydration, and increased metabolic demand. Cardiovascular manifestations include sinus tachycardia, atrial fibrillation, congestive heart failure, pulmonary oedema, hypotension, and cardiogenic shock. Neurological abnormalities range from agitation, anxiety, and delirium to psychosis, seizures, and coma. Gastrointestinal manifestations include nausea, vomiting, abdominal pain, and diarrhoea, while severe hepatic involvement may result in jaundice and impaired liver function [3-5]. The simultaneous occurrence of several of these findings in a patient with known or suspected hyperthyroidism should raise immediate concern for thyroid storm.

Diagnostic scoring systems

Two principal clinical frameworks support the recognition and classification of thyroid storm. These are the Burch–Wartofsky Point Scale (BWPS) and the Japanese Thyroid Association/Japan Endocrine Society (JTA/JES) diagnostic criteria. Both systems help clinicians organize clinical findings, estimate the likelihood of thyroid storm, and

identify patients who may require urgent intensive care. However, neither should replace clinical judgement, and neither has been validated against an independent diagnostic gold standard [6,8,9]. The Burch–Wartofsky Point Scale assigns numerical values to abnormalities involving thermoregulation, the central nervous system, the gastrointestinal and hepatic systems, and cardiovascular function. It also incorporates the presence of a precipitating event. The total score reflects the cumulative severity of the clinical manifestations and provides a practical framework for evaluating patients presenting with suspected thyroid storm [6,8,9]. Under the BWPS, a temperature of 38–38.5°C receives 5 points, whereas temperatures exceeding 40.6°C receive 30 points. Central nervous system manifestations receive between 10 and 30 points, depending on severity. Gastrointestinal symptoms such as diarrhoea, abdominal pain, nausea, and vomiting receive 10 points, while severe hepatic dysfunction manifested by jaundice receives 20 points. Cardiovascular assessment includes heart rate, congestive heart failure, and atrial fibrillation. Heart rates of 90–109 beats/min receive 5 points, while rates of 140 beats/min or greater receive 25 points. Congestive heart failure contributes between 5 and 15 points, depending on clinical severity, and atrial fibrillation contributes 10 points. The presence of a precipitating event contributes an additional 10 points [6]. The total BWPS score is interpreted using three principal categories. A score below 25 indicates that thyroid storm is unlikely, a score of 25–44 suggests an impending or possible thyroid crisis, and a score of 45 or greater strongly supports the diagnosis. A score of at least 45 in an appropriate clinical context warrants immediate treatment for thyroid storm. Patients scoring between 25 and 44 require careful evaluation because they may have an evolving crisis or severe thyrotoxicosis without established multiorgan decompensation. Decisions regarding aggressive treatment in this intermediate category should consider the clinical trajectory, organ dysfunction, alternative diagnoses, and specialist assessment [6,9].

One advantage of the BWPS is its flexibility. It allows clinicians to assess the combined effects of several abnormalities rather than relying on a single diagnostic feature. Nevertheless, its reliance on clinical manifestations may reduce specificity in critically ill patients. Fever and tachycardia can occur in sepsis, severe dehydration, cardiogenic shock, drug toxicity, and other acute conditions. Assigning points to these findings without considering their underlying causes may overestimate the likelihood of thyroid storm. Therefore, the score should be interpreted in conjunction with the patient's history, thyroid function results, and response to initial treatment. The JTA/JES criteria provide an alternative diagnostic framework derived from clinical registry data. Unlike the BWPS, these criteria require biochemical

evidence of thyrotoxicosis, demonstrated by elevated free thyroxine (FT4) and/or free triiodothyronine (FT3), together with specified combinations of clinical manifestations. The major features include central nervous system disturbance, fever of at least 38°C, tachycardia of at least 130 beats/min, congestive heart failure, and gastrointestinal or hepatic dysfunction. Severe gastrointestinal or hepatic involvement may include nausea, vomiting, diarrhoea, or a total bilirubin concentration of at least 3 mg/dL [8]. The JTA/JES framework classifies patients as having definite thyroid storm (TS1) or suspected thyroid storm (TS2). Definite thyroid storm is diagnosed when biochemical thyrotoxicosis accompanies at least one central nervous system manifestation and one or more additional systemic features. It may also be diagnosed when at least three qualifying features are present among fever, tachycardia, congestive heart failure, and gastrointestinal or hepatic dysfunction. Suspected thyroid storm is considered when biochemical thyrotoxicosis accompanies at least two qualifying non-neurological features. The criteria also provide a pathway for patients with history or clinical signs of thyroid disease when thyroid function test results are not immediately available but the clinical presentation otherwise meets the relevant diagnostic requirements [8]. The JTA/JES criteria offer a structured approach that may improve consistency in clinical classification. Their requirement for biochemical evidence helps distinguish thyroid storm from some alternative causes of systemic deterioration. However, the categorical structure may fail to identify early or evolving cases in which the full combination of clinical features has not yet developed. In emergency settings, laboratory results may also be delayed, and clinicians should not postpone necessary resuscitation or treatment while awaiting confirmation when the clinical suspicion is high.

Comparison and limitations of diagnostic criteria

The BWPS and JTA/JES criteria differ in their structure, biochemical requirements, and diagnostic thresholds. The BWPS uses a weighted numerical score and does not require biochemical confirmation as a prerequisite for calculating the score. The JTA/JES system uses defined combinations of clinical features and ordinarily requires elevated FT3 and/or FT4. The former offers flexibility in assessing cumulative clinical severity, whereas the latter provides explicit categorical definitions for definite and suspected thyroid storm [6,8]. Neither framework reliably separates every case of thyroid storm from severe, uncomplicated thyrotoxicosis. Published evidence on their diagnostic sensitivity and specificity remains limited, partly because thyroid storm is uncommon and no independent gold standard exists. The BWPS may produce high scores in patients with sepsis or other critical illnesses, while the JTA/JES criteria may be

less sensitive to incomplete presentations. These limitations are especially relevant in intensive care units, where fever, tachycardia, altered consciousness, and organ dysfunction may arise from several overlapping causes. Clinical assessment must therefore remain central to the diagnostic process. Clinicians should establish whether the patient's deterioration is consistent with excessive thyroid hormone activity, evaluate the timing and progression of symptoms, and investigate possible precipitating events. Thyroid function testing should include serum TSH and free T4, with free T3 measurement where appropriate. In severe thyrotoxicosis, TSH is generally suppressed, while FT4 and/or FT3 are elevated. Additional investigations should be guided by the presentation and may include a complete blood count, electrolytes, glucose, renal and liver function tests, electrocardiography, cardiac biomarkers, blood cultures, and imaging when indicated. These investigations help identify complications, assess organ dysfunction, and detect alternative or concurrent diagnoses.

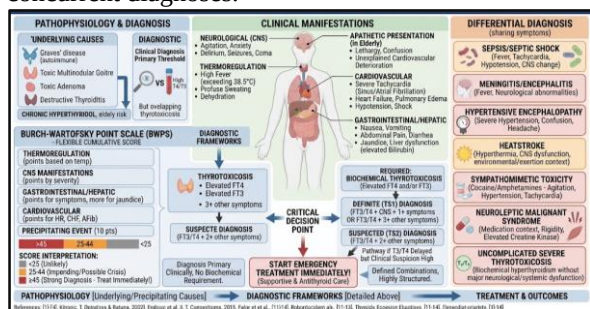


Figure-2: Diagnostic Approaches of thyroid storm.

Atypical presentations and differential diagnosis

Older adults may develop thyroid storm without the pronounced adrenergic manifestations typically associated with hyperthyroidism. This presentation, sometimes described as apathetic hyperthyroidism, may involve lethargy, weakness, confusion, reduced activity, or unexplained cardiovascular deterioration. Marked agitation, tremors, or severe tachycardia may be absent. Clinicians should therefore maintain a high index of suspicion in older patients with unexplained acute illness, particularly when a history of thyroid disease or suggestive examination findings are present [10]. The differential diagnosis includes several conditions that share features with thyroid storm. Sepsis can cause fever, tachycardia, hypotension, and altered mental status, particularly when infection progresses to septic shock. Meningitis and encephalitis may produce fever and neurological abnormalities, while hypertensive encephalopathy can cause confusion, headache, and visual disturbances in patients with severe hypertension. Heatstroke should be considered when hyperthermia follows environmental exposure or strenuous exertion. Sympathomimetic toxicity, including exposure to cocaine or amphetamines, may cause agitation, hypertension, and tachycardia.

Neuroleptic malignant syndrome should also be considered in patients with relevant medication exposure, muscle rigidity, altered consciousness, and elevated creatine kinase. Severe but uncomplicated thyrotoxicosis is another important differential diagnosis, particularly when biochemical hyperthyroidism is present without substantial neurological dysfunction or systemic decompensation. In conclusion, the recognition and diagnosis of thyroid storm require an integrated approach combining clinical assessment, biochemical investigations, diagnostic scoring systems, and evaluation of alternative causes of acute deterioration. The BWPS and JTA/JES criteria provide useful complementary frameworks, but neither should be interpreted as an independent diagnostic test. Early identification of cardiovascular instability, neurological dysfunction, hepatic involvement, and precipitating conditions is essential. When thyroid storm is strongly suspected, emergency treatment and supportive care should begin promptly rather than being delayed while awaiting completion of diagnostic investigations [10].

Treatment of Thyroid Storm

The treatment of thyroid storm requires immediate, coordinated intervention to control excessive thyroid hormone activity, stabilize cardiovascular and respiratory function, correct metabolic disturbances, and treat the precipitating cause. Management recommendations from the American Thyroid Association (ATA) and the European Thyroid Association (ETA) emphasize a multimodal approach that combines supportive care, adrenergic blockade, inhibition of thyroid hormone synthesis and release, reduction of peripheral thyroid hormone effects, and treatment of the underlying trigger [5,11]. Because thyroid storm can progress rapidly to cardiovascular collapse and multiorgan failure, treatment should begin as soon as the diagnosis is strongly suspected rather than waiting for all laboratory results. Patients with suspected or confirmed thyroid storm should receive treatment in a high-dependency unit or intensive care unit when significant organ dysfunction or clinical instability is present. Indications for intensive care include hemodynamic instability requiring vasopressors or invasive monitoring, altered consciousness, respiratory failure requiring ventilatory support, acute heart failure, cardiogenic shock, persistent clinically significant arrhythmias, multiorgan dysfunction, and rapid deterioration despite initial treatment. Early involvement of endocrinologists, intensivists, emergency physicians, cardiologists, and surgeons supports coordinated decision-making. Surgical teams should be informed early when severe disease is refractory to medical treatment or emergency thyroidectomy may become necessary [5,11].

General supportive measures

Initial management follows the principles of emergency resuscitation, including assessment and stabilization of airway, breathing, and circulation. Continuous monitoring of temperature, heart rate, blood pressure, oxygen saturation, cardiac rhythm, urine output, glucose, and neurological status is essential. Intravenous access should be established, and laboratory investigations should assess electrolyte disturbances, renal function, hepatic function, glucose concentrations, and evidence of infection or other precipitating conditions. Echocardiography may be required to evaluate ventricular function and identify thyrotoxic cardiomyopathy or acute heart failure. Hyperthermia should be managed with external cooling measures and paracetamol. Aspirin should generally be avoided because it can displace thyroid hormones from plasma-binding proteins, transiently increasing circulating free thyroxine and triiodothyronine concentrations. Intravenous fluids may be necessary to correct dehydration caused by fever, sweating, vomiting, and diarrhoea. However, fluid administration must be individualized because excessive volume can worsen pulmonary oedema in patients with heart failure. Electrolyte abnormalities and hypoglycaemia require prompt correction, while nutritional support and vitamin replacement, including thiamine when indicated, should be considered in patients with poor nutritional intake [10]. Treatment of the precipitating condition is equally important. Antibiotics should be initiated promptly when bacterial infection or sepsis is suspected, with appropriate microbiological investigations where feasible. Myocardial infarction, stroke, diabetic ketoacidosis, trauma, and other acute illnesses require condition-specific management. A pregnancy test should be performed in women of childbearing potential because pregnancy influences medication selection and subsequent treatment decisions. Thyroid storm during pregnancy requires coordinated care involving endocrinology, obstetrics, critical care, and neonatal specialists because both maternal and fetal outcomes may be affected [10]. Atrial fibrillation is common during thyroid storms. Decisions regarding anticoagulation should consider conventional stroke-risk assessment, such as the CHA₂DS₂-VASc score, together with bleeding risk and the clinical context. Some patients return to sinus rhythm after restoration of euthyroidism, but the immediate management of haemodynamic instability and significant arrhythmia remains a priority [10,12]. Clinicians should also anticipate respiratory deterioration and provide oxygen or ventilatory support when required.

Beta-adrenergic blockade

Beta-blockers are a central component of thyroid storm treatment because they reduce adrenergic manifestations, including tachycardia, tremors, agitation, and increased myocardial workload. Propranolol is commonly recommended

for hemodynamically stable patients, with guideline regimens including 60–80 mg orally every four hours. At sufficiently high doses, propranolol also reduces peripheral conversion of thyroxine (T₄) to the more biologically active triiodothyronine (T₃) [5,11]. However, beta-blockade requires particular caution in patients with hypotension, reduced left ventricular function, thyrotoxic cardiomyopathy, or evolving cardiogenic shock. In these circumstances, sympathetic stimulation may be maintaining cardiac output, and abrupt beta-blockade can precipitate cardiovascular collapse. Assessment of cardiac function before treatment, including echocardiography when indicated, can help guide drug selection and dosing. Intravenous esmolol may be preferred when rapid adjustment or discontinuation of beta-blockade is necessary because of its short half-life. A commonly described regimen includes a loading dose of 500 micrograms/kg over one minute, followed by a titrated infusion of up to 200 micrograms/kg/minute, according to the clinical response and local protocol. Intravenous propranolol and labetalol are alternatives in selected patients, but their use also requires careful monitoring. When beta-blockers are contraindicated, diltiazem may provide rate control, although it must be used cautiously in patients with impaired ventricular function. Comparative observational studies have not established a universal mortality advantage for one beta-blocker over another, supporting individualized selection based on cardiac function, haemodynamic stability, and local availability [12].

Antithyroid medication

High-dose antithyroid medication inhibits new thyroid hormone synthesis and is a fundamental component of treatment. Methimazole (MMI), carbimazole (CBZ), and propylthiouracil (PTU) are the principal options. PTU inhibits thyroid peroxidase-mediated hormone synthesis and also reduces peripheral conversion of T₄ to T₃. Methimazole and carbimazole primarily inhibit thyroid hormone synthesis. Suggested regimens include MMI at 60–80 mg/day or CBZ at 80–100 mg/day. An alternative is PTU, administered as a loading dose of 500–1,000 mg orally or through a nasogastric tube, followed by 250 mg every four hours. Rectal administration may be considered when enteral administration is not feasible, using appropriate formulation and specialist guidance. These high-dose regimens require close monitoring and should be implemented under specialist supervision. Although PTU has the theoretical advantage of reducing peripheral T₄-to-T₃ conversion, observational studies have not demonstrated a clear mortality benefit compared with methimazole in thyroid storm [13]. Hepatic function is an important consideration when selecting treatment. Abnormal liver enzymes may result from thyrotoxicosis, hepatic congestion, or hypoperfusion. Mild abnormalities do not automatically preclude

antithyroid treatment, but substantial or progressive hepatic dysfunction should prompt careful assessment because PTU can cause severe hepatotoxicity. Methimazole or carbimazole may be preferable in significant liver dysfunction, depending on the clinical circumstances and specialist advice. Severe hepatic injury warrants consideration of hepatology consultation [5]. Once the patient improves, antithyroid medication should be reduced to a maintenance regimen according to thyroid function results and clinical response. Cholestyramine, commonly administered at 4 g three times daily, may be used as an adjunct because it reduces enterohepatic recirculation of thyroid hormones and promotes their elimination. Lithium can also inhibit thyroid hormone release in selected refractory cases, but its narrow therapeutic range and potential toxicity require specialist supervision [5].

Corticosteroid therapy

Glucocorticoids are recommended as part of multimodal treatment because they reduce peripheral conversion of T4 to T3 and provide coverage for possible relative adrenal insufficiency during severe physiological stress. A commonly used regimen is intravenous hydrocortisone, with a loading dose of 100 mg followed by 50 mg every six hours. The dose and duration should be adjusted according to clinical response and local protocols. Corticosteroids may be particularly useful in severe Graves' disease and in patients with significant systemic illness. However, clinicians should monitor glucose concentrations, electrolytes, and clinical signs of complications. High-dose glucocorticoids have been associated with thyrotoxic periodic paralysis in susceptible patients. Potassium should therefore be monitored closely, particularly in individuals at increased risk of this complication [12].

Iodine and potassium iodide

Iodine preparations inhibit thyroid hormone release through the acute Wolff–Chaikoff effect and can rapidly reduce hormone secretion in patients with hyperthyroidism caused by increased hormone synthesis. They are generally used in combination with antithyroid medication rather than as a substitute for it. Iodine should be administered at least one hour after the antithyroid drug to reduce the risk that additional iodine will serve as a substrate for further hormone synthesis. Regimen described in clinical guidance include Lugol's iodine, eight drops four times daily, or saturated potassium iodide solution, five drops four times daily. The preparation and concentration must be verified because formulations vary. Oral preparations should be diluted appropriately before administration because concentrated iodine solutions can irritate mucosal surfaces. Treatment is generally discontinued once the patient is stabilized, according to specialist guidance. The role of iodine depends on the cause of thyrotoxicosis. It is useful in Graves' disease and

toxic multinodular goitre, where increased hormone synthesis is present. It is less likely to benefit from destructive thyroiditis or factitious thyrotoxicosis, in which circulating hormones originate from damaged thyroid tissue or exogenous hormone administration. Its use in amiodarone-induced thyrotoxicosis requires particular consideration because iodine exposure and underlying disease mechanisms differ between subtypes [12]. Excess iodine can interfere with subsequent radioactive iodine treatment by reducing thyroidal uptake. Radioactive iodine therapy is therefore generally deferred until sufficient iodine clearance occurs, often for at least two to three months, depending on the preparation, iodine exposure, and clinical circumstances.

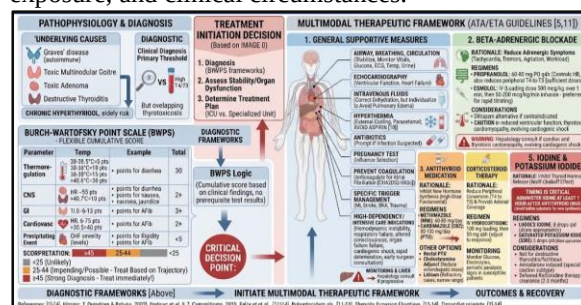


Figure-3: Comprehensive Treatment and Management of Thyroid Storm.

Definitive management and follow-up

After the acute crisis is resolved, treatment should address the underlying cause of hyperthyroidism and prevent recurrence. Patients commonly continue antithyroid medication while thyroid function is monitored. Definitive treatment may involve radioactive iodine therapy or thyroidectomy, depending on the etiology, disease severity, contraindications, patient preferences, and clinical circumstances. Surgery may be considered in patients who fail medical treatment or cannot receive other definitive therapies, but it should be undertaken by an experienced team after appropriate stabilization whenever possible. Overall, successful management of thyroid storm depends on early recognition, rapid supportive care, appropriate control of adrenergic activity, inhibition of thyroid hormone synthesis and release, and treatment of the precipitating condition. Individualized treatment is essential because cardiac dysfunction, hepatic injury, pregnancy, and other comorbidities may substantially influence therapeutic decisions. Intensive monitoring and coordinated multidisciplinary care remain central to reducing complications and improving survival.

Ongoing Management of Thyroid Storm

Ongoing management of thyroid storm focuses on maintaining clinical stability, monitoring the response to treatment, transitioning to maintenance therapy, and determining the most appropriate strategy for definitive control of hyperthyroidism. Although substantial clinical improvement often occurs within 24–72 hours after

treatment begins, the rate of recovery depends on the severity of the initial presentation, the underlying thyroid disorder, the presence of complications, and the effectiveness of treatment of precipitating factors. Continuous reassessment is essential because apparent improvement in one organ system does not necessarily indicate complete resolution of the systemic crisis.

Monitoring Clinical and Biochemical Recovery

The transition from emergency treatment to maintenance therapy should occur once haemodynamic, thermoregulatory, and neurological stability has been achieved. Important indicators of improvement include resolution of fever, a progressive reduction in heart rate, stable blood pressure, reduced or discontinued vasopressor requirements, recovery of consciousness, and improvement in gastrointestinal symptoms. Respiratory function, urine output, renal function, hepatic function, and electrolyte concentrations should also be monitored to identify persistent or developing organ dysfunction. Serial measurements of free thyroxine (FT4) and free triiodothyronine (FT3) help assess the biochemical response to treatment. Concentrations generally decline over several days, although the rate of reduction varies with the underlying cause and the treatment regimen. FT3 may decline more rapidly when propylthiouracil or glucocorticoids are administered because these agents inhibit peripheral conversion of T4 to T3. Thyroid-stimulating hormone (TSH) is less useful during the early recovery period because its suppression may persist after circulating thyroid hormone concentrations begin to normalize. Consequently, early treatment decisions should rely primarily on clinical improvement and serial FT4 and FT3 measurements rather than TSH alone. Failure to achieve clinical stabilization within 24–48 hours should prompt a systematic reassessment. Clinicians should investigate persistent infection, untreated myocardial infarction, ongoing metabolic disturbances, inadequate antithyroid drug administration, impaired gastrointestinal absorption, and complications such as thyrotoxic cardiomyopathy. Treatment delivery may be compromised in patients with severe vomiting, ileus, altered consciousness, or gastrointestinal dysfunction. In these circumstances, alternative routes of administration or additional therapeutic interventions may be required. Persistent cardiovascular instability should also prompt reassessment of cardiac function and the need for advanced haemodynamic support.

Adjustment of Pharmacological Treatment

As the patient improves, treatment should be adjusted according to the clinical response, thyroid hormone concentrations, and the likelihood of adverse effects. Iodide therapy is generally discontinued once the acute crisis is controlled and its continued use is no longer necessary. Prolonged administration should be avoided unless a specific

indication remains because the inhibitory effect of excess iodine on thyroid hormone release may be transient. In addition, iodine exposure can interfere with subsequent radioactive iodine treatment. Beta-blockade should be continued while clinically significant thyrotoxicosis and adrenergic manifestations persist, provided the patient's cardiovascular status permits its use. The dose should be reassessed frequently, particularly in patients with impaired ventricular function, hypotension, or a history of cardiogenic shock. Abrupt or excessive beta-blockade may compromise cardiac output in patients whose circulation depends on compensatory sympathetic stimulation. Once heart rate and haemodynamic status improve, the dose can be adjusted under appropriate monitoring [5]. Glucocorticoids may be tapered or discontinued after clinical stabilization when there is no evidence of accompanying adrenal insufficiency or another indication for continued treatment. The duration of therapy should reflect the severity of the crisis, the response to treatment, and the risk associated with prolonged corticosteroid exposure. Antithyroid medication should generally continue until a definitive long-term management plan has been established. Dose reduction should be guided by clinical improvement, thyroid hormone concentrations, and specialist assessment rather than by an arbitrary timetable [5].

Transition to Maintenance Therapy and Definitive Treatment

Following recovery from thyroid storm, patients require continued treatment of the underlying hyperthyroidism to prevent recurrence. Long-term management depends on the etiology, previous treatment history, comorbidities, contraindications, and patient preferences. The main options include continued antithyroid medication, radioactive iodine therapy, and thyroidectomy. Antithyroid drugs may be continued as maintenance treatment in patients who respond adequately and do not develop significant adverse effects. Regular monitoring of thyroid function is necessary to guide dose adjustment and detect recurrent hyperthyroidism or treatment-induced hypothyroidism. Patients should receive clear instructions regarding medication adherence and the need to seek medical assessment if symptoms of thyrotoxicosis recur. Education about the potential adverse effects of antithyroid drugs is also important, particularly symptoms that may indicate agranulocytosis or hepatic injury. Definitive treatment should be discussed before discharge whenever appropriate. Radioactive iodine therapy may be suitable for selected patients with Graves' disease or toxic nodular disease, depending on contraindications and clinical circumstances. Thyroidectomy may be preferred when rapid definitive control is necessary, when a large goitre causes compressive symptoms, when malignancy is suspected, or when medical treatment is ineffective or

unsuitable. Patients who undergo thyroidectomy require postoperative monitoring and an appropriate plan for thyroid hormone replacement. Some patients may require thyroidectomy during the initial admission because of persistent instability or failure to respond to medical treatment. In such cases, surgery should be undertaken by an experienced endocrine surgical team with critical care support. When immediate surgery is unnecessary, the timing of definitive treatment should be determined after stabilization, with consideration of the patient's underlying thyroid disorder and the risks associated with each option [5,6,13].

Escalation of Treatment in Refractory Thyroid Storm

Patients who remain unstable despite appropriate supportive care, antithyroid medication, beta-blockade when suitable, glucocorticoids, and iodine when indicated require a structured escalation strategy. Before introducing rescue interventions, clinicians should confirm that standard treatments have been administered correctly, evaluate drug absorption, review contraindications, and identify persistent precipitating factors. Haemodynamic and ventilatory support should be optimized while the multidisciplinary team reassesses the treatment plan. Cholestyramine may be added as an adjunct to reduce enterohepatic recirculation of thyroid hormones and increase their elimination. It does not replace standard treatment but may contribute to a more rapid decline in circulating hormone concentrations. Other pharmacological adjustments, including changes in glucocorticoid therapy or the use of additional agents, should be considered according to the clinical circumstances and specialist advice. Therapeutic plasma exchange is an established rescue option that may be considered in severe, refractory thyrotoxicosis or multiorgan failure despite maximal medical treatment. The procedure removes circulating thyroid hormones and thyroid hormone-binding proteins, allowing a temporary reduction in hormone concentrations. However, its effects may be transient, and it carries risks associated with vascular access, haemodynamic changes, bleeding, and replacement fluids. Evidence supporting its use in thyroid storm is derived mainly from observational studies and case series. Plasma exchange is therefore generally considered a bridge to definitive treatment rather than a replacement for antithyroid therapy or surgery [5]. Emergency thyroidectomy may be necessary when medical treatment fails, when severe adverse effects prevent the use of antithyroid drugs, or when rapid control of hormone production is essential. Surgery during an uncontrolled thyroid crisis carries substantial anesthetic and perioperative risks. It should therefore be considered in specialized centers with experienced endocrine surgeons, anesthetists, endocrinologists, and intensive care teams. Selected high-risk patients may require

individualized anesthetic approaches when conventional general anaesthesia presents unacceptable risks [14]. Venoarterial extracorporeal membrane oxygenation (VA-ECMO) may provide temporary circulatory support in patients with refractory cardiogenic shock associated with severe thyrotoxic cardiomyopathy. By supporting systemic perfusion, VA-ECMO may allow time for thyroid hormone concentrations to decline and cardiac function to recover. Its use requires specialized facilities and carries risks including bleeding, thrombosis, infection, and vascular complications. Evidence for VA-ECMO in thyroid storm remains limited, but successful cases have been reported, particularly when severe cardiac dysfunction is potentially reversible [15].

Rare and Context-Specific Therapies

Perchlorate and iodinated contrast agents such as iopanoic acid have been described as additional treatment options in selected cases of refractory thyroid storm. These agents are not routinely available in many healthcare systems, and evidence supporting their use is limited. Perchlorate inhibits thyroidal iodide uptake, potentially reducing thyroid hormone synthesis. Iopanoic acid has been reported to inhibit peripheral conversion of T4 to T3 and may also reduce thyroid hormone release. However, availability, regulatory status, safety, and evidence of clinical benefit vary. Their use should be restricted to specialist settings after careful assessment of potential benefits and risks [14].

Discharge Planning and Long-Term Follow-Up

Discharge should occur only after sustained clinical stability, adequate control of the precipitating condition, and establishment of a safe medication and follow-up plan. Patients should have a documented strategy for ongoing antithyroid treatment, monitoring of thyroid function, and definitive management where indicated. Follow-up with an endocrinologist is essential to assess recovery, adjust medication, evaluate adverse effects, and determine the timing of radioactive iodine therapy or surgery. In summary, ongoing management of thyroid storms require systematic monitoring, careful adjustment of acute therapies, and timely transition to long-term control of hyperthyroidism. Failure to stabilize should prompt reassessment and escalation to specialist rescue interventions when necessary. Early planning for definitive treatment, together with patient education and continued endocrine follow-up, is essential to reduce recurrence and improve long-term outcomes [12].

Conclusion:

Thyroid storm remains a critical endocrine emergency requiring rapid recognition, coordinated multidisciplinary management, and individualized treatment. Its diagnosis depends primarily on clinical assessment, supported by diagnostic frameworks such as the Burch-Wartofsky Point Scale and

Japanese Thyroid Association criteria, neither of which should replace clinical judgment. Identifying precipitating factors, including infection, surgery, trauma, and cardiovascular events, is essential for directing treatment and preventing further deterioration. Effective management combines intensive supportive care with beta-blockers, antithyroid medications, iodine, and glucocorticoids, alongside prompt treatment of the underlying trigger. Patients with severe cardiovascular instability or multiorgan dysfunction require close monitoring and timely escalation of care. In refractory cases, adjunctive pharmacological approaches, therapeutic plasma exchange, thyroidectomy, or extracorporeal support may be considered in appropriately selected patients. Ultimately, improved awareness, early intervention, evidence-informed protocols, and appropriate follow-up are central to reducing complications and improving survival.

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